國立臺北科技大學

九十二學年度電腦通訊與控制研究所入學考試

電磁學試題

填准考證號碼

注意事項：

1. 本試題共【10】題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. **(a) Write the set of four instantaneous Maxwell's equations in both integral and differential forms. (8%) (b) Write the two constitutive relations of a medium. (2%)**

2. **(a) Write the four general electromagnetic boundary conditions between any two media. (8%) (b) Provide the mathematical expressions for both the electrostatic energy density ($Jouls/m^3$) in terms of the $\bar{E}$ field and the magnetostatic energy density ($Jouls/m^3$) in terms of the $\bar{H}$ field. (2%)**

3. **State in words (a) Helmholtz's theorem (5%) and (b) the uniqueness theorem of electrostatics. (5%)**

4. **Prove in math that any electrostatic potential V_{21} is completely independent of the path taken between points 1 and 2. (10%)**

5. **Derive the equation of continuity $\nabla \bullet \bar{J} = -\frac{\partial \rho}{\partial t}$ from the principle of conservation of charge where $\bar{J}$ is volume current density and ρ is the volume charge density. (10%)**

6. **Show in math that the capacitance C and conductance G between any two conductors separated by a homogeneous medium satisfies $\frac{C}{G}=\frac{\varepsilon}{\sigma}$. (10%)**

7. **Derive the homogeneous vector Helmhotz's equation $\nabla^2\vec{E}+k^2\vec{E}=0$ for a simple, non-conducting source-free medium where $\vec{E}$ is expressed in phasor form and $k=\omega\sqrt{\mu\varepsilon}$. (10%)**

8. **Prove that $\oint_s \vec{P}\bullet d\vec{s}=-\frac{\partial}{\partial t}\int_v(\frac{1}{2}\varepsilon E^2+\frac{1}{2}\mu H^2)d\upsilon-\int_v(\sigma E^2)d\upsilon$ where both $\vec{E}$ and $\vec{H}$ are expressed in instantaneous form and $\vec{P}=\vec{E}\times\vec{H}$ is the Poynting vector. (10%)**

9. **Show in math that the input impedance Z_i seen into a lossless transmission line terminated in Z_L is given as $Z_i=Z_0\frac{Z_L+jZ_0\tan\beta\ell}{Z_0+jZ_L\tan\beta\ell}$ where Z_0, β, and ℓ are the characteristic impedance, phase constant, and physical length of the transmission line, respectively. (10%)**

10. **(a) What is a Smith Chart? (2%) (b) Why does the radius of a Smith Chart not exceed unity for a passive device? (2%) (c) State the physical meaning of the voltage standing wave ratio on a transmission line. (2%) (d) What does "matched transmission line" mean? (2%) (e) What are the advantages of double-stub matching over single-stub matching? (2%)**